ESP-WROOM-02

Datasheet

About This Guide

This document introduces the user to the specification of ESP-WROOM-02 hardware, including the following topics:

Chapter	Title	Subject
Chapter 1	Overview	Provides overview introduction to ESP-WROOM-02, including dimensions and specifications.
Chapter 2	Pin Definition	Provides introduction to pin layout and the relevant description.
Chapter 3	Functional Description	Describes major functional modules and protocols applied on ESP-WROOM-02, including CPU, flash and memory,and interfaces.
Chapter 4	Electrical Characteristic	Lists the electrical data of ESP-WROOM-02.
Chapter 5	Schematics	Provides ESP-WROOM-02 schematics.
Appendix	Notices	FCC/CE/IC/KCC compliance statements.

Release Notes

Date	Version	Release notes
2015.12	V0.5	First release.
2016.01	V0.6	Section 3.2.2 updated.
2016.02	V0.7	Added Appendix – Noices. Updated Chapter 1.

Table of Contents

1.   Overview

Espressif provides SMD module – ESP-WROOM-02 in which ESP8266EX is embedded. It is recommended to use ESP-WROOM-02 for test or further development.

The module size is 18 x 20mm. The type of flash used on this module is an SPI flash with the package size of SOP 8-150mil. The gain of the on-board PCB antenna is 2 DBi.
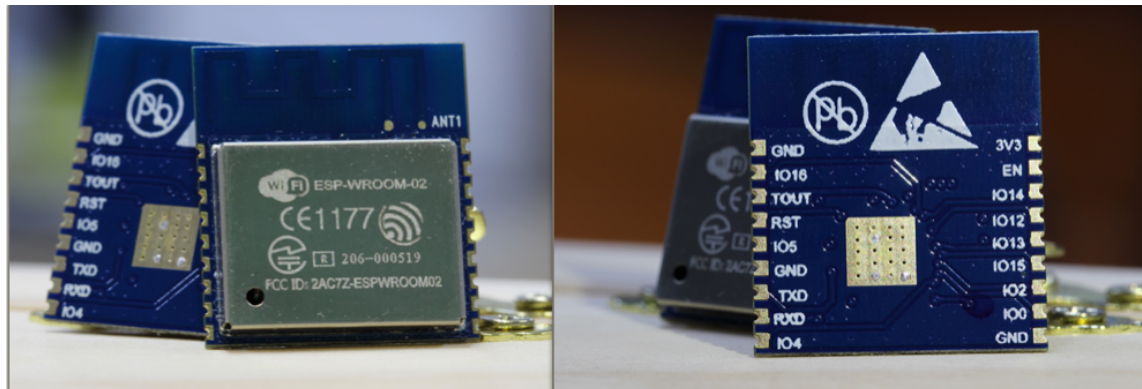

Figure 1-1. ESP-WROOM-02 module

Table 1-1. ESP-WROOM-02 specifications

Categories	Items	Specifications
Wi-Fi	Standards	FCC/CE/TELEC
	Wi-Fi protocols	802.11 b/g/n
	Frequency range	2.4 GHz ~ 2.5 GHz (2400M ~ 2483.5M)
Hardware	Peripheral interface	UART/HSPI/I2C/I2S/Ir Remote Contorl
		GPIO/PWM
	Operating voltage	3.0 ~ 3.6V
	Operating current	Average: 80mA
	Operating temperature range	-40℃ ~ 125℃
	Ambient temperature range	Normal temperature
	Package size	18mm x 20mm x 3mm
	External interface	-
Software	Wi-Fi mode	station/softAP/SoftAP+station
	Security	WPA/WPA2
	Encryption	WEP/TKIP/AES
	Firmware upgrade	UART Download / OTA (via network) / download and write firmware via host

Categories	Items	Specifications
	Software development	Supports Cloud Server Development / SDK for custom firmware development
	Network protocols	IPv4, TCP/UDP/HTTP/FTP
	User configuration	AT Instruction Set, Cloud Server, Android/iOS App

2. Pin Description

The pin distribution of the SMD Module is illustrated in Figure 2-1.
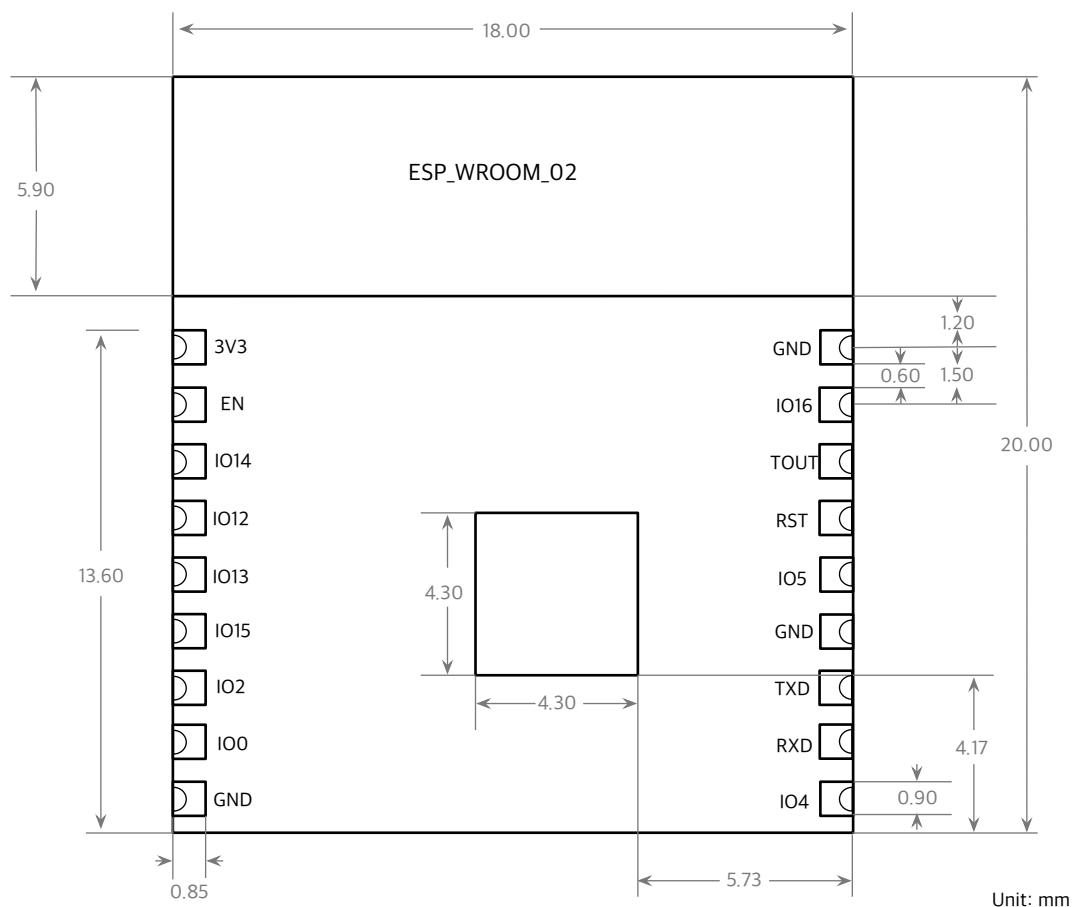
Figure 2-1. Top view of ESP-WROOM-02

Table 2-1. ESP-WROOM-02 dimensions

Length	Width	Height	PAD size (bottom)	Pin pitch
18 mm	20 mm	3 mm	0.9 mm x 1.7 mm	1.5 mm

ESP-WROOM-02 has 18 pins, see the pin definitions in Table 2-2.

Table 2-2. ESP-WROOM-02 pin definitions

No.	Pin name	Functional description
1	3V3	3.3V power supply (VDD)
2	EN	Chip enable pin. Active high

No.	Pin name	Functional description
3	IO14	GPIO14; HSPI_CLK
4	IO12	GPIO12; HSPI_MISO
5	IO13	GPIO13; HSPI_MOSI; UART0_CTS
6	IO15	GPIO15; MTDO; HSPICS; UART0_RTS
7	IO2	GPIO2; UART1_TXD
8	IO0	GPIO0
9	GND	GND
10	IO4	GPIO4
11	RXD	UART0_RXD; GPIO3
12	TXD	UART0_TXD; GPIO1
13	GND	GND
14	IO5	GPIO5
15	RST	Reset
16	TOUT	It can be used to test the power-supply voltage of VDD3P3 (Pin3 and Pin4) and the input power voltage of TOUT (Pin 6). These two functions cannot be used simultaneously.
17	IO16	GPIO16; Wake up the chipset from deep sleep mode when connected to RST pin.
18	GND	GND

Table 2-3. UART Download mode

GPIO15	GPIO0	GPIO2
Low	Low	High

Table 2-4. Flash Boot mode

GPIO15	GPIO0	GPIO2
Low	High	High

3. Functional Description

3.1. MCU

ESP8266EX integrates Tensilica L106 32-bit micro controller (MCU), which features extra low power consumption and 16-bit RSIC. The CPU clock speed ranges from 80 MHz to 160 MHz.

ESP8266EX supports external sensors and other specific devices through its GPIOs; codes for such applications are provided in examples in the SDK.

3.2. Memory

3.2.1. Internal SRAM and ROM

ESP8266EX Wi-Fi SoC integrates memory controller including SRAM and ROM. MCU can access the memory units through iBus, dBus, and AHB interfaces. All memory units can be accessed upon request, while a memory arbiter will decide the running sequence according to the time when these requests are received by the processor.

According to our current version of SDK provided, SRAM space available to users is assigned as below:

- RAM size < 50KB, that is, when ESP8266EX is working under the station mode and is connected to the router, programmable space accessible in heap + data section is around 50KB.
- There is no programmable ROM in the SoC, therefore, user program must be stored in an external SPI flash.

3.2.2. External SPI Flash

ESP-WROOM-02 can be mounted with a 2MB or 4MB external SPI flash to store user programs. If larger definable storage space is required, a SPI flash with larger memory size is preferred. Theoretically speaking, up to 16 MB memory capacity can be supported.

- OTA is disabled: the minimum flash memory that can be supported is 512 kB
- OTA is enabled: the minimum flash memory that can be supported is 1MB

Several SPI modes can be supported, including Standard SPI, Dual SPI, and Quad SPI.

Therefore, select the correct SPI mode when downloading programs into the flash, otherwise firmwares/programs that you downloaded may not work in the right way.

> ⚠ Notice:
>
> Select the correct SPI mode when downloading programs into the flash, otherwise errors may occur.

3.3. Crystal Oscillators

ESP-WROOM-02 can support 40 MHz, 26 MHz and 24 MHz crystal oscillators. The accuracy of crystal oscillators applied should be ±10 PPM, and the operating temperature range should be between −20℃ and 85℃.

When using the download tools, remember to select the right crystal oscillator type. In circuit design, capacitors C1 and C2, which are connected to the earth, are added to the input and output terminals of the crystal oscillator respectively. The values of the two capacitors can be flexible, ranging from 6pF to 22pF, however, the specific capacitive values of C1 and C2 depend on further testing and adjustment on the overall performance of the whole circuit. Normally, the capacitive values of C1 and C2 are within 10pF if the crystal oscillator frequency is 26 MHz, while the values of C1 and C2 are 10pF<C1, C2<22pF if the crystal oscillator frequency is 40 MHz.

3.4. Interface Description

Table 3-1. Interface description

Interface	Pin	Functional description
HSPI	IO12 (MISO), IO13 (MOSI), IO14 (CLK), IO15 (CS)	SPI Flash 2, display screen, and MCU can be connected using HSPI interface.
PWM	IO12 (R), IO15 (G),IO13 (B)	Currently the PWM interface has four channels, but users can extend the channels according to their own needs. PWM interface can be used to control LED lights, buzzers, relays, electronic machines, and so on.
IR	IO14 (IR_T), IO5 (IR_R)	The functionality of Infrared remote control interface can be implemented via software programming. NEC coding, modulation, and demodulation are used by this interface. The frequency of modulated carrier signal is 38KHz.
ADC	TOUT	ESP8266EX integrates a 10-bit analog ADC. It can be used to test the power- supply voltage of VDD3P3 (Pin 3 and Pin 4) and the input power voltage of TOUT (Pin 6). However, these two functions cannot be used simultaneously. This interface is typically used in sensor products.
I2C	IO14 (SCL), IO2 (SDA)	I2C interface can be used to connect external sensor products and display screens, etc.
UART	UART0: TXD (U0TXD), RXD (U0RXD), IO15 (RTS), IO13 (CTS) UART1: IO2 (TXD)	Devices with UART interfaces can be connected with the module. Downloading: U0TXD+U0RXD or GPIO2 + U0RXD Communicating: UART0: U0TXD, U0RXD, MTDO (U0RTS), MTCK (U0CTS) Debugging: UART1_TXD (GPIO2) can be used to print debugging information.

Interface	Pin	Functional description
		By default, UART0 will output some printed information when the device is powered on and is booting up. If this issue exerts influence on some specific applications, users can exchange the inner pins of UART when initializing, that is to say, exchange U0TXD, U0RXD with U0RTS, U0CTS.
I2S	I2S input: IO12 (I2SI_DATA) ; IO13 (I2SI_BCK); IO14 (I2SI_WS); I2S output: IO15 (I2SO_BCK); IO3 (I2SO_DATA); IO2 (I2SO_WS).	I2S interface is mainly used for collecting, processing, and transmission of audio data.

4. Electrical Characteristics

4.1. Absolute Maximum Ratings

Table 4-1. Absolute Maximum Ratings

Rating	Condition	Value	Unit
Storage temperatue	-	-40 ~ 125	℃
Maximum soldering temperature	-	260	℃
Supply voltage	IPC/JEDEC J-STD-020	+3.0 ~ +3.6	V

4.2. Recommended Operating Conditions

Table 4-2. Recommended operating conditions

Operating condition	Symbol	Min	Typ	Max	Unit
Operating temperature	-	-40	20	125	℃
Supply voltage	VDD	3.0	3.3	3.6	V

4.3. Digital Terminal Characteristics

(VDD = 3.3V, TA = 20℃, unless otherwise specified.)

Table 4-3. Digital terminal characteristics

Terminals	Symbol	Min	Typ	Max	Unit
Input logic level low	V_{IL}	-0.3	-	0.25VDD	V
Input logic level high	V_{IH}	0.75VDD	-	VDD+0.3	V
Output logic level low	V_{OL}	N	-	0.1VDD	V
Output logic level high	V_{OH}	0.8VDD	-	N	V

4.4. RF Performance

Table 4-4. RF performance

Description	Min	Typ	Max	Unit
Input frequency	2400	–	2483.5	MHz
Input impedance	–	50	–	ohm
Input reflection	–	–	–10	dB
Output power of PA for 72.2 Mbps	15.5	16.5	17.5	dBm
Output power of PA for 11b mode	19.5	20.5	21.5	dBm
Sensitivity				
CCK, 1 Mbps	–	–98	–	dBm
CCK, 11 Mbps	–	–91	–	dBm
6 Mbps (1/2 BPSK)	–	–93	–	dBm
54 Mbps (3/4 64–QAM)	–	–75	–	dBm
HT20, MCS7 (65 Mbps, 72.2 Mbps)	–	–72	–	dBm
Adjacent channel rejection				
OFDM, 6 Mbps	–	37	–	dB
OFDM, 54 Mbps	–	21	–	dB
HT20, MCS0	–	37	–	dB
HT20, MCS7	–	20	–	dB

4.5. Sensitivity

Table 4-5. Sensitivity

Parameters	Min	Typ	Max	Unit
Input frequency	2412	-	2484	MHz
Input impedance	-	50	-	Ω
Input reflection	-	-	-10	dB
Output power of PA for 72.2 Mbps	15.5	16.5	17.5	dBm
Output power of PA for 11b	19.5	20.5	21.5	dBm
Sensitivity	-	-	-	-
DSSS, 1 Mbps	-	-98	-	dBm
CCK, 11 Mbps	-	-91	-	dBm

Parameters	Min	Typ	Max	Unit
6 Mbps (1/2 BPSK)	-	-93	-	dBm
54 Mbps (3/4 64-QAM)	-	-75	-	dBm
HT20, MCS7 (65 Mbps, 72.2 Mbps)	-	-72	-	dBm
Adjacent channel rejection	-	-	-	-
OFDM, 6 Mbps	-	37	-	dB
OFDM, 54 Mbps	-	21	-	dB
HT20, MCS0	-	37	-	dB
HT20, MCS7	-	20	-	dB

4.6. Power Consumption

Table 4-6. Power consumption

Modes	Min	Typ	Max	Unit
Tx 802.11b, CCK 11 Mbps, P_{OUT}=+17dBm	-	170	-	mA
Tx 802.11g, OFDM 54 Mbps, P_{OUT} =+15dBm	-	140	-	mA
Tx 802.11n, MCS7, P_{OUT} =+13dBm	-	120	-	mA
Rx 802.11b, 1024 bytes packet length , -80dBm	-	50	-	mA
Rx 802.11g, 1024 bytes packet length , -70dBm	-	56	-	mA
Rx 802.11n, 1024 bytes packet length , 65dBm	-	56	-	mA
Modem-Sleep①	-	15	-	mA
Light-Sleep②	-	0.9	-	mA
Deep-Sleep③	-	10	-	uA
Power Off	-	0.5	-	uA

Notes:

- Modem-Sleep requires the CPU to be working, as in PWM or I2S applications. According to 802.11 standards (like U-APSD), it saves power to shut down the Wi-Fi Modem circuit while maintaining a Wi-Fi connection with no data transmission. E.g. in DTIM3, to maintain a sleep 300ms- wake 3ms cycle to receive AP's Beacon packages, the current is about 15mA.
- During Light-Sleep, the CPU may be suspended in applications like Wi-Fi switch. Without data transmission, the Wi-Fi Modem circuit can be turned off and CPU suspended to save power according to the 802.11 standard (U-APSD). E.g. in DTIM3, to maintain a sleep 300ms-wake 3ms cycle to receive AP's Beacon packages, the current is about 0.9mA.
- Deep-Sleep does not require Wi-Fi connection to be maintained. For application with long time lags between data transmission, e.g. a temperature sensor that checks the temperature every 100s, sleep 300s and waking up to connect to the AP (taking about 0.3 ~ 1s), the overall average current is less than 1mA.

4.7. Reflow Profile

Table 4-7. Reflow Profile

|	
T_S max to TL (Ramp-up Rate)	3℃/second max
Preheat Temperature Min. (T_S Min.) Temperature Typ. (T_S Typ.) Temperature Min. (T_S Max.) Time (T_S)	150℃ 175℃ 200℃ 60 ~ 180 seconds
Ramp-up rate (T_L to T_P)	3℃/second max
Time maintained above: --Temperature(T_L)/ Time(T_L)	217℃/60 - 150 seconds
Peak temperature (T_P)	260℃ max , for 10 seconds
Target peak temperature (T_P Target)	260℃ +0/-5℃
Time within 5℃ of actual peak(t_P)	20 ~ 40 seconds
T_S max to T_L (Ramp-down Rate)	6℃/second max
Tune 25℃ to Peak Temperature (t)	8 minutes max

5. Schematics
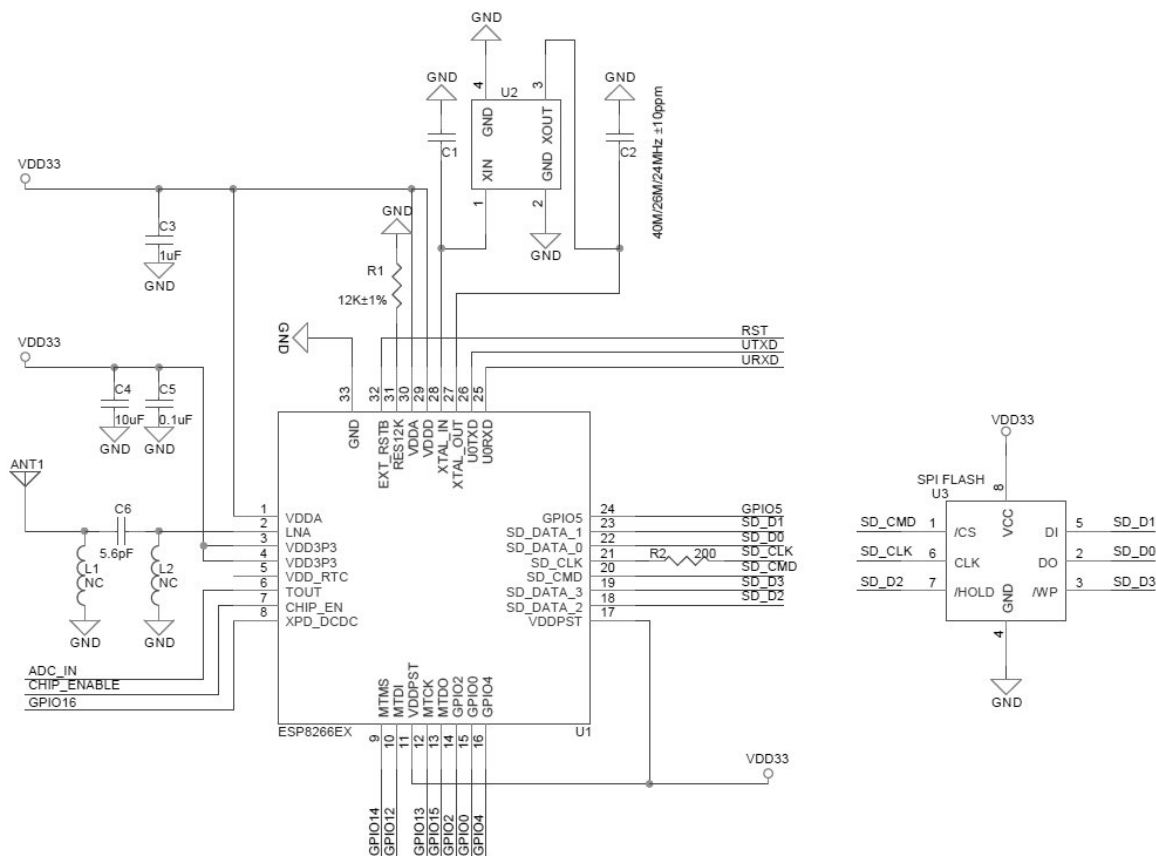
Figure 5-1. ESP-WROOM-02 schematics

Appendix - Notices

I. Federal Communications Commission (FCC) Declaration of Conformity

This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and the receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

Any changes or modifications to this equipment not expressly approved by Espressif may cause harmful interference and void the user's authority to operate this equipment.

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

FCC Radiation Exposure Statement

This equipment complies with FCC radiation exposure limits set forth for an uncontrolled environment. This equipment should be installed and operated with minimum distance 20cm between the radiator& your body.

This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

II. EC Declaration of Conformity

This equipment can be used in member states of the European Union once the corresponding administrative license is obtained.

Espressif, as manufacturer of the product ESP-WROOM-02, declares that the said product complies with the essential requirements established in Article 3 of the Council of Europe Directive 1999/5/ CE, dated 9th March, 1999.

III. Industry Canada (IC) Compliance Notice

III.1. IC RSS warning

This device complies with Industry Canada licence-exempt RSS standard(s). Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device.

Le présent appareil est conforme aux CNR d'Industrie Canada applicables aux appareils radio exempts de licence.

L'exploitation est autorisée aux deux conditions suivantes:

(1) l'appareil ne doit pas produire de brouillage, et

(2) l'utilisateur de l'appareil doit accepter tout brouillage radioélectrique subi, même si le brouillage est susceptible d'en compromettre le fonctionnement.

III.2. IC Radiation Exposure Statement

This equipment complies with IC RF radiation exposure limits set forth for an uncontrolled environment. This transmitter must not be co-located or operating in conjunction with any other antenna or transmitter.

This equipment should be installed and operated with minimum distance 20cm between the radiator& your body.

Any changes or modifications not expressly approved by Espressif responsible for compliance could void the user's authority to operate the equipment.

IV. Korea Communications Commission (KCC) Statement

인증받은자의 상호: ESPRESSIF SYSTEMS (SHANGHAI) PTE LTD
제품명 / 모델명:특정소출력 무선기기(무선데이타통신시스템용 무선기기 / ESP-WROOM-02
제조자 및 제조국가: ESPRESSIF SYSTEMS (SHANGHAI) PTE LTD / China
제조년월:2016.02
인증번호:MSIP-CRM-es5- ESP-WROOM-02
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